



Possible hybridization between East Pacific Green *Chelonia mydas* and Olive Ridley *Lepidochelys olivacea* sea turtles in northwest Mexico

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Abstract.—Photographic records of sea turtle neonates and embryos which show characteristics of both East Pacific Green Sea Turtles (*Chelonia mydas*) and Olive Ridley Sea Turtles (*Lepidochelys olivacea*) are presented. These turtles were produced from nests laid by Olive Ridley females in the states of Nayarit, Jalisco, and Baja California Sur. Their discovery further suggests the occurrence of hybridization between these two species, and potential implications for conservation are discussed.

Keywords. Black sea turtle, Gulf of California, morphology, conservation, hybrid, Testudines

Citation: Hart CE, Ley-Quñonez CP, Abreu-Grobois FA, Plata-Rosas LJ, Llamas-Gonzalez I, Ocegüera-Camacho DKE, Zavala-Norzagaray AA. 2019. Possible hybridization between East Pacific Green *Chelonia mydas* and Olive Ridley *Lepidochelys olivacea* sea turtles in northwest Mexico. *Amphibian & Reptile Conservation* 13(2) [General Section]: 174–180 (e202).

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Received: 24 April 2017; **Accepted:** 13 July 2018; **Published:** 19 November 2019

Introduction

Sea turtles are widely distributed throughout tropical and subtropical oceans. They nest on sandy beaches throughout their range, and while different species can be found sharing habitats worldwide each has adapted to take advantage of different ecological niches (Tomas et al. 2001; Ballorain et al. 2010; Jones et al. 2012). Despite this, where species of the same lineage coincide in time and space mating and inter-specific hybridization sometimes occurs naturally, a process which influences 25% of plant and 10% of animal species (Arnold 1997). When hybridization involves threatened or endangered species it is considered to be of conservation concern (Allendorf et al. 2001), and there is a need to determine whether these events are a result of anthropogenic factors before implementing management strategies (Genovart 2009). Of the seven extant species of sea turtles, hybridization has been reported between Loggerheads (*Caretta caretta*) and Kemp's (*Lepidochelys kempii*) [Barber et al. 2003]; Loggerheads and Hawksbills (*Eretmochelys imbricata*) [Lara-Ruiz et al. 2006]; Greens (*Chelonia mydas*) and Loggerheads (James et al. 2004); Greens and Hawksbills

(Seminoff et al. 2003; Kelez et al. 2016); and Hawksbills and Olive Ridleys (*L. olivacea*) [Lara-Ruiz et al. 2006]. Thus, the Caretteni and Chelonini tribes to which they belong are thought to be one of the oldest vertebrate lineages that is known to hybridize in nature (Karl et al. 1995), sharing a common ancestor more than 50 million yr ago (Bowen et al. 1993; Dutton et al. 1996).

Along the Pacific coast of Mexico, nesting occurs for four species of sea turtles: Leatherback, Hawksbill, Green, and Olive Ridley, with the latter being by far the most abundant. East Pacific Green Turtles are the second most abundant turtle to nest on Mexico's Pacific beaches, and they often nest alongside Olive Ridleys. These two species have overlapping breeding seasons with Olive Ridleys nesting from May to December (Garcia et al. 2003) and Greens from September to January (Alvarado-Díaz et al. 2003). Currently both species exhibit incipient recovery and nearly year-round nesting as a result of the population increases following decades of conservation activities. Extensive hunting and egg collection, which reached industrial levels in the 1970s and 1980s, led to drastic population declines (Chassin-Noria et al. 2004; Rodríguez-Zarate et al. 2013). These declines

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Fig. 1. Northwest Mexico. Circles denote nesting beaches where suspected hybrid hatchlings have been observed.

were reversed with a total ban on sea turtle use starting in 1990 (Marquez et al. 1998) and the proliferation of conservation programs. Improvements in the conditions of these species have resulted in both being moved from the Endangered to Vulnerable classifications on the IUCN Red List, although both species remain listed in Appendix I of CITES (2007).

Here, the possible hybridization of East Pacific Green Sea Turtles and Olive Ridley Turtles is reported in northwest Mexico based on hatchling characteristics.

Materials and Methods

During 2010–2012, hatchlings and embryos from 12 nests laid by different Olive Ridley females were observed with characteristics (see Table 1) typically associated with East Pacific Green Turtles. Conservation biologists collaborating with two NGOs in north-west Mexico, Red Tortuguera A.C. and Grupo Tortuguero de las Californias A.C., were requested to report embryos and neonates that were atypically pigmented, or those that presented scute or morphological patterns associated

with a species different than that of the female which had nested. Following the subsequent reports, photographic records of the neonates were made prior to their release.

Results

All of the hatchling sea turtles that presented atypical characteristics hatched from nests verified to be laid by Olive Ridley females. Figures 2A and 2B show the contrasting morphology and coloration of the carapace and plastron for Olive Ridley and East Pacific Green Turtle hatchlings, respectively. Embryos (Fig. 3) and hatchlings (Figs. 4–5) were occasionally found presenting coloration typical of East Pacific green turtle hatchlings. Interestingly these hatchlings were often the only abnormal hatchlings from an otherwise typical Olive Ridley clutch, with their siblings presenting typical Olive Ridley coloration.

Olive Ridley hatchlings presenting a white border to the marginal scutes and white edges to the flippers were frequently reported (Fig. 6). We consider this to be a normal characteristic, and not a sign of hybridization, that

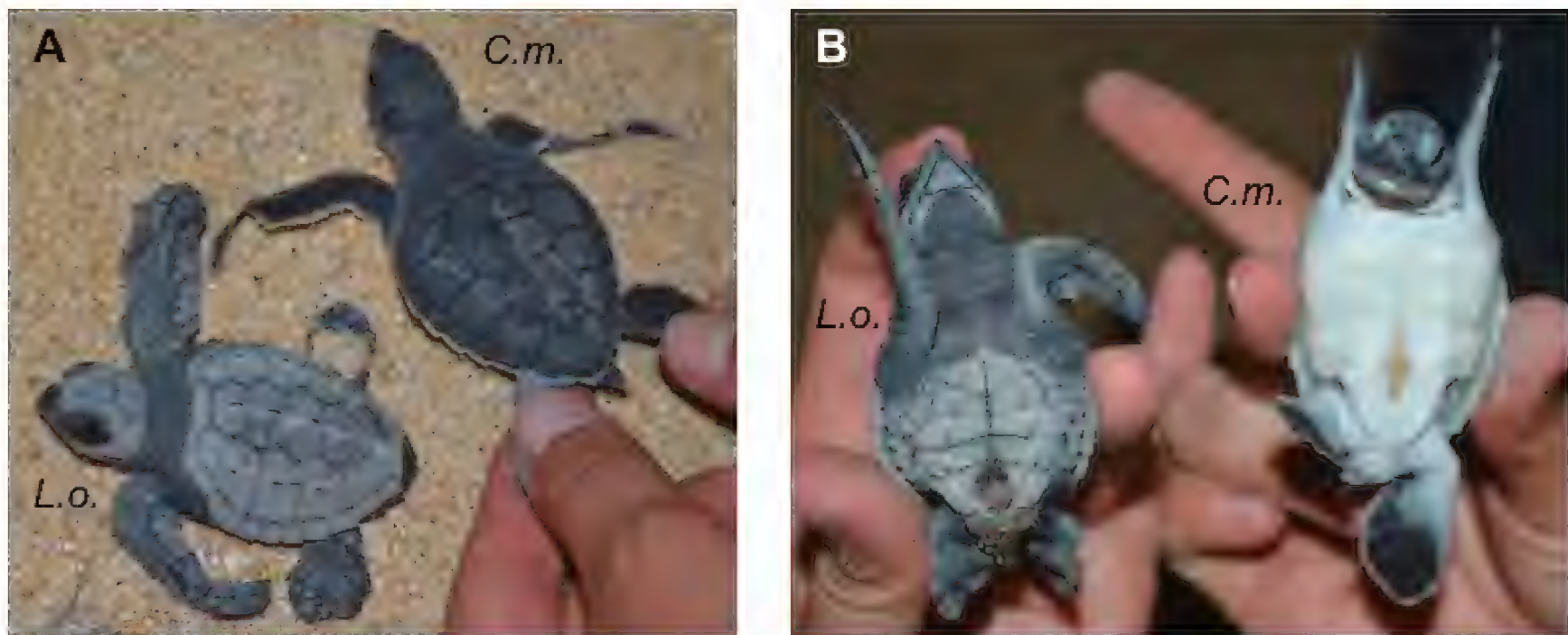


Fig. 2. Carapace (A) and plastron (B) of *Lepidochelys olivacea* (L.o.) and *Chelonia mydas* (C.m.) hatchlings.



Fig. 3. Embryo from an Olive Ridley nest, clearly displaying East Pacific Green Turtle coloration on both (A) plastron and flippers, and (B) carapace. Photos by C.E. Hart.

Table 1. Morphological features of putative hybrid neonate turtles compared to those usually reported for *Lepidochelys olivacea* and *Chelonia mydas*.

Morphological feature	<i>L. olivacea</i>	<i>C. mydas</i>	Putative hybrids
Prefrontal scales	4	2	2 or 4
Post orbital scales	3	3	3
Marginal scutes	12	11	11–12
Supracaudal scutes	2	2	2
Intergular scute		Yes	
Postanal scute		No	
Nuchal scute	Yes	Yes	Yes
Lateral scutes	6–9*	4	4–8
Vertebral scutes	6–9	5	6–7
Inframarginal scutes		4	
Keels	Yes	No	Yes
Beak	Triangular	Rounded, large	Triangular or rounded
Anterior claws	2	1	1–2
Carapace color	Gray	Black	Dark gray or black
Plastron color	Gray	White	White

*occasionally five

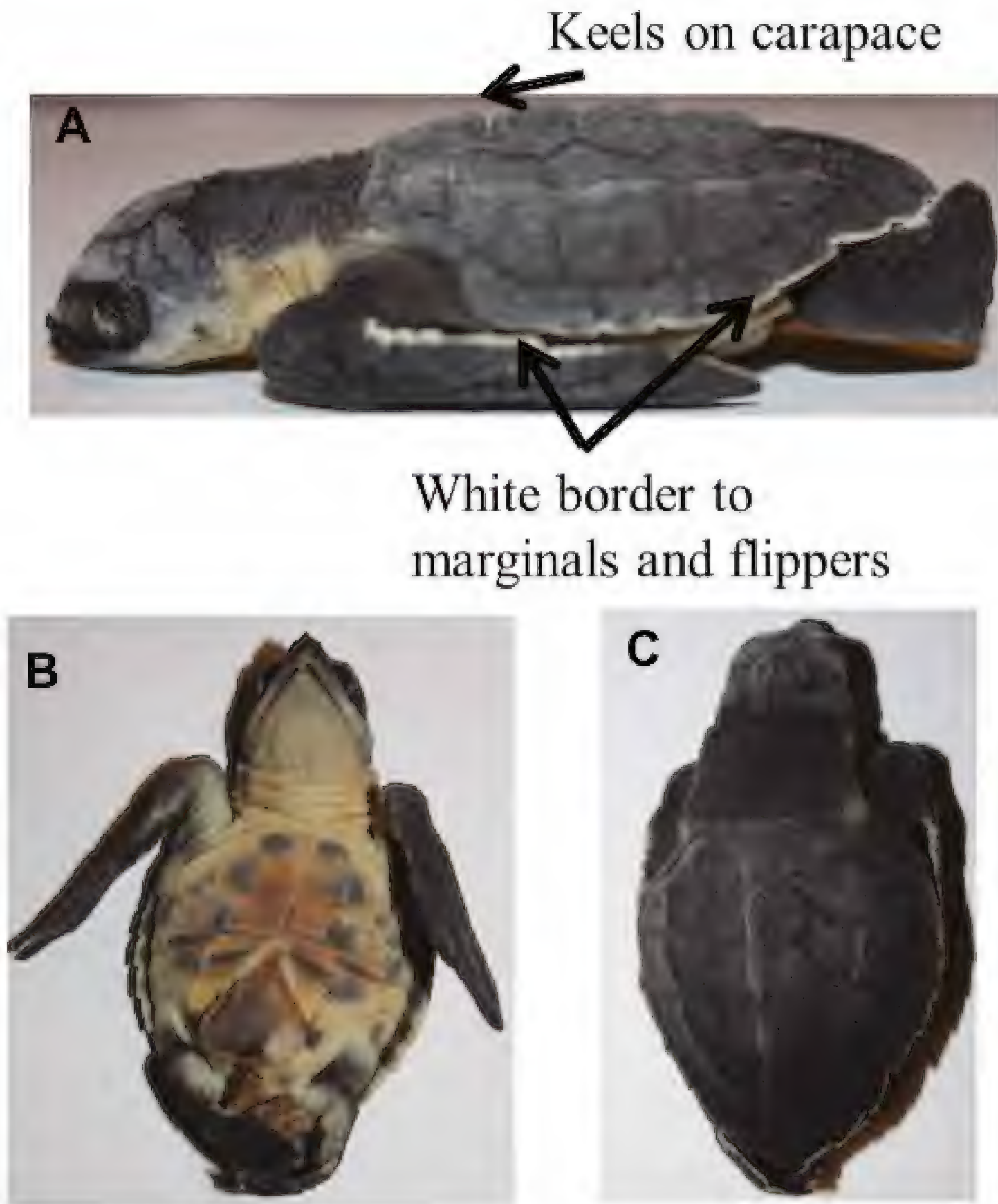


Fig. 4. Deceased hatchling presenting (A) white coloration to the carapace and flipper border, and (B) the white plastron characteristic of East Pacific Green Turtles, while presenting (C) a typical Olive Ridley carapace and head. *Photos by C.E. Hart.*



Fig. 5. Healthy neonate turtles presenting characteristics of both East Pacific Green and Olive Ridley Turtles photographed before release. *Photos by C.E. Hart (A) and F. Sanchez (B).*

is present in some but not all Olive Ridley neonates and is found within all participating hatcheries in southern Nayarit and north Jalisco. However, a white border on the marginal scutes and white edges to the flippers are characteristics associated with East Pacific Green

Turtle neonates, and they have not been described as pigmentation for Olive Ridley neonates. Genetic studies are needed to clarify whether these neonates are pure Olive Ridelies or the result of hybridization.

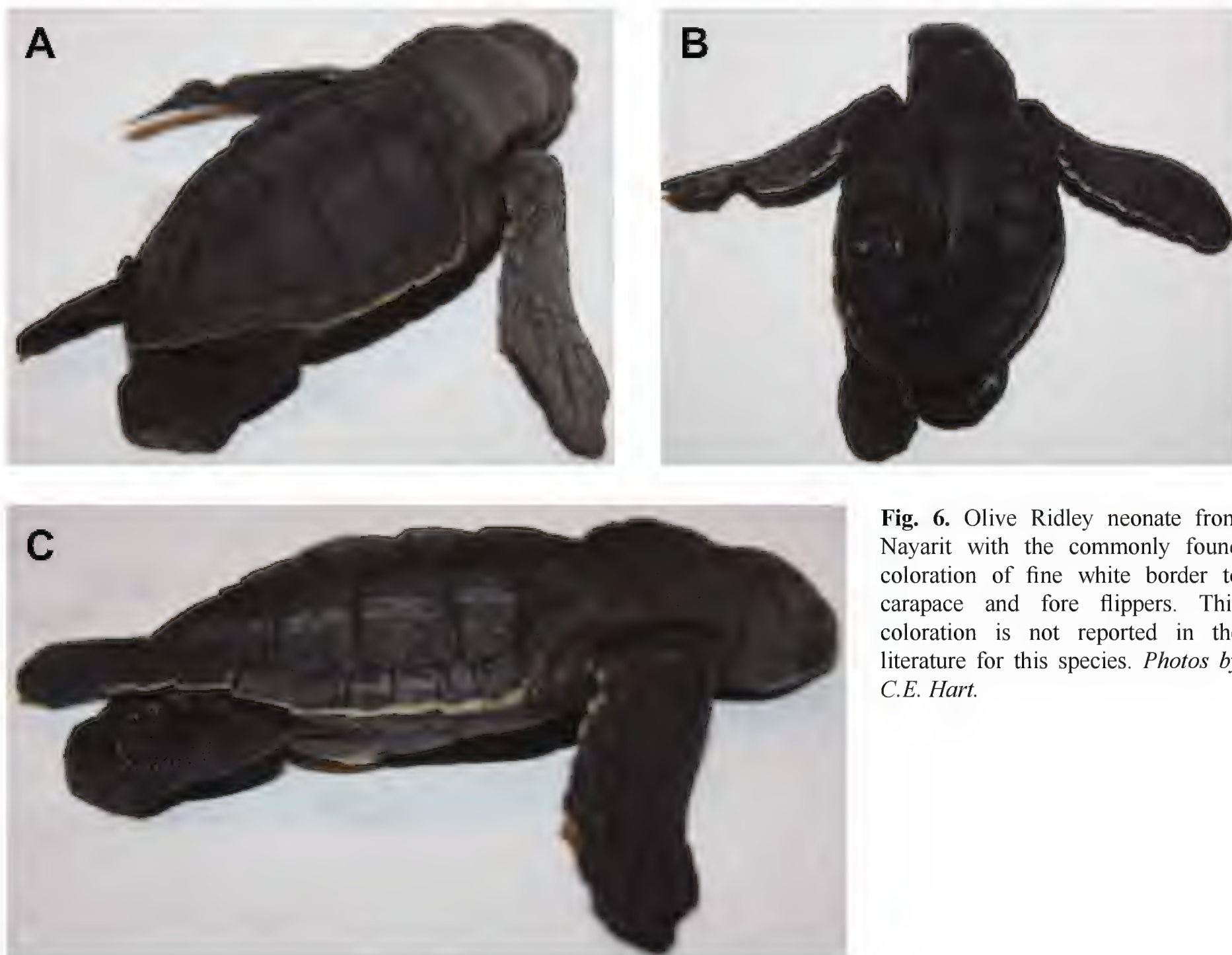


Fig. 6. Olive Ridley neonate from Nayarit with the commonly found coloration of fine white border to carapace and fore flippers. This coloration is not reported in the literature for this species. *Photos by C.E. Hart.*

Discussion

Olive Ridley turtles are the most abundant of all sea turtle species, and this is particularly evident in the East Pacific, with an estimated 1.39 million large juvenile and adult Olive Ridley turtles in the Tropical East Pacific (Eguchi et al. 2007). Because the vast differences in abundance would greatly increase the opportunities for hybridization of Olive Ridelys with East Pacific Green Turtles, there is concern that if these become widespread they could jeopardize the recovery of the much smaller East Pacific Green Turtle population. For example, hybrids could be sterile and so reduce overall fertility. Hawksbill-Loggerhead hybrids have been found to be fertile in Brazil where introgression (breeding of hybrids with one or both parental taxa) has become significant (Lara-Ruiz et al. 2006). Furthermore, Soares et al. (2017) found that Loggerhead-Hawksbill hybrids were at no reproductive disadvantage relative to the pure Hawksbills among which they nested, suggesting that these hybrids are likely to persist there.

Many studies report either sterility or low fitness in hybrids (Allendorf et al. 2001). However, reports from conservation projects in northwest Mexico suggest that putative Olive Ridley-Green Turtle hybrid hatchlings are

more fit (being first to the water on release) than the Olive Ridley turtles that hatch from the same and/or different nests. However, the report of a more aggressive behavior by some of these hybrid hatchlings is also worrying.

We recommend using these illustrations to aid a national program aimed at compiling information on the frequency and locations of occurrence of atypical hatchlings within conservation projects, in order to gauge the importance of this phenomenon, coupled with genetic analyses to definitively confirm hybridization. If confirmed hybridization is found to be abundant, possible impacts on the regional populations are a cause for concern. We hope this information will open the conversation on the issue of hybridization between sea turtle species in Mexico and highlight the need for appropriate management guidelines to advise conservation projects on the action to take (if any) when these neonates occur.

Acknowledgments.—CEH would like to thank the Consejo Nacional de Ciencia y Tecnología (CONACYT) Mexico for support through a Ph.D. Scholarship (number 310163). We would also like to thank the many *Tortugueros* who have been keeping an eye out for “strange hatchlings.”

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Possible hybridization of *Chelonia mydas* and *Lepidochelys olivacea*



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